PATENT ABSTRACTS OF JAPAN

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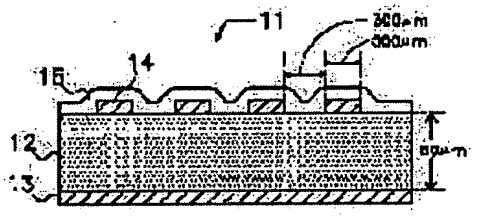
(54) FERROELECTRTIC ELECTRON EMISSION COLD CATHODE

(57)Abstract:

PROBLEM TO BE SOLVED: To ensure a stable and large emission amount of electrons with a long service life by forming a protection film of high electron emission material on a main surface to emit electrons.



SOLUTION: A ferroelectric PZT thin plate of bulk shape with sizes of 10×15 mm and a thickness of 50 μm and an Ir electrode having a film thickness of 500 nm layed over the whole rear surface of the plate are formed by spattering as a lower surface electrode 13. On the front surface thereof, as an upper surface electrode 14, an Ir electrode having a film thickness of 100 nm is formed in a stripe shape with a line of 500 μm and a space of 300 μm. On the whole front surface including the upper surface electrode 14, an MgO film serving as a protection film 15 is formed with a film thickness of 100 nm by an EB depostion method to thereby form a ferroelectric electron emission cathode 11. By forming the protection film 15 in this way, electrons are emitted similarly with the initinal case of starting application of voltage even if the number of application of pulse voltage exceeds 1000, and the amount of emission is made sufficiently stable. Also, by forming the film 15, the amount of emission itself is increased by about 30%.

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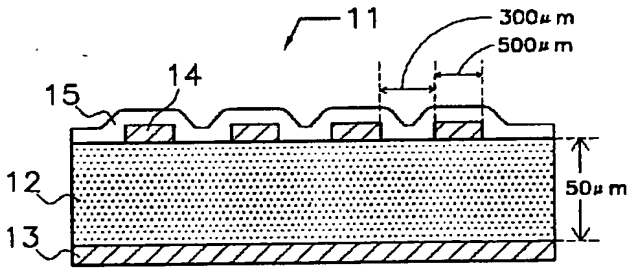
(54)【発明の名称】　強誘電体電子放出冷陰極

(57)【要約】
【課題】　寿命が長く、大きな電子の放出量を安定して得られる強誘電体電子放出冷陰極を提供する。
【解決手段】　強誘電体の両主面に裏面電極と上面電極とを有してなる強誘電体電子放出冷陰極において、上面電極の形成された他方主面上に、二次電子放出能の高い材料、例えばＭｇＯ、ＺｎＯ、CeO_2、Y_2O_3、ＢａＯ、ＣａＯ、ＳｒＯからなる保護膜を形成する。



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【特許請求の範囲】

【請求項１】　自発分極を有する強誘電体と、強誘電体の一方主面に形成される裏面電極と、強誘電体の他方主面に形成される上面電極とを有してなる強誘電体電子放出冷陰極であって、

前記上面電極の形成された強誘電体の他方主面上に、電子放出能の高い材料からなる保護膜を形成したことを特徴とする強誘電体電子放出冷陰極。

【請求項２】　前記保護膜の材料として、ＭｇＯ、ＺｎＯ、CeO_2、Y_2O_3、ＢａＯ、ＣａＯ、ＳｒＯの中から選ばれる少なくとも１種を用いたことを特徴とする請求項１に記載の強誘電体電子放出冷陰極。

【請求項３】　前記上面電極が、ストライプ状、メッシュ状またはアレイ状に形成されていることを特徴とする請求項１に記載の強誘電体電子放出冷陰極。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電子源として利用する電子放出冷陰極に関するものであり、特に強誘電体を用いた電子放出冷陰極の構造に関するものである。

【０００２】

【従来の技術】強誘電体には、平行または反平行に並んだ永久双極子によって生じる自発分極が存在しており、外部から摂動を与えることによってこれを変化させることが可能である。例えば、電場による分極変化は分極履歴現象（ヒステリシス）として観測され、また応力や温度変化を与えるとそれぞれ圧電効果や焦電効果となって現れる。これらの現象は、強誘電体上に形成された電極への電荷の出入りによって観測されるが、電極の形状あるいは形成位置、膜厚等を適切に選択することにより、強誘電体からの電子の放出も可能となる。

【０００３】上述の強誘電体からの電子放出現象については、従来より様々な研究が行われており、例えば$BaTiO_3$等の代表的な強誘電体単結晶に、外部から電界の印加、温度変化、光照射等の摂動を与えて分極変化を誘起すると言った各種の実験が行われていた。しかしこれらの実験は比較的緩やかな分極変化を用いたものであり、放出される電子の電流密度も10^{-9}Ａ／ｃｍ^{2}と極めて小さなものであったため、実用的なデバイスへの応用は困難であると考えられていた。ところが、近年になってチタン酸ジルコン酸鉛（以下、ＰＺＴと略す）や、これに少量のＬａを添加したＰＬＺＴなどの強誘電体セラミックに高速パルス電界を印加することにより、１０～10^2Ａ／ｃｍ^{2}程度の電子放出がなされることがH. Ｇｕｎｄｅｌらによって報告されて以来、この現象を電子デバイスへ応用しようとする機運が高まっている。

【０００４】例えば、H. Ｇｕｎｄｅｌらによって報告された強誘電体電子放出冷陰極１は、図１に示すように、下面電極２、強誘電体３、上面電極４をその主たる構成要素とし、また例えば特開平５－３２５７７７号公報に記載された強誘電体電子放出冷陰極５は、図２に示すように、下面電極２、強誘電体３、上面電極４に加えて絶縁膜６、補助電極７をその主たる構成要素としている。これら図１、図２に示された構成の強誘電体電子放出冷陰極は、下面電極と上面電極との間に交番電界を印加することにより、その電界の急激な変化に伴い強誘電体内部に分極の変化（分極反転）を生ぜしめ、その際に上面電極の近傍に存在する電子をクーロン力によってはじき飛ばし、電子の放出を行うものであると考えられる。

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【０００５】

【発明が解決しようとする課題】しかしながら上述の強誘電体電子放出冷陰極は、以下のような問題点を有していた。

【０００６】すなわち従来の冷陰極にあっては、下面電極と上面電極との間に交番電界を印加して強誘電体内に分極反転を生ぜしめる動作を繰り返すと、強誘電体表面および／または上面電極内部に疲労および劣化が生じ、次第に電子の放出が行われなくなる。この劣化は通常、数回～数十回程度のパルス電圧の印加で生じるため、本冷陰極をそのまま実用に供することは不可能であった。この劣化を抑制するために印加するパルス電圧の絶対値を小さくすることも考えられるが、この場合、放出される電子の電流密度が小さくなるという問題が新たに生じる。また従来の冷陰極では、未だ充分満足のゆくだけの電子放出量が得られておらず、かつその放出量も不安定であると言う問題点を有していた。

【０００７】これらの問題点から、強誘電体を用いた電子放出冷陰極は未だ実用化されていないのが現状である。従って本発明の目的は、上述の技術的問題点を克服し、寿命が長く、大きな電子の放出量を安定して得られる強誘電体電子放出冷陰極を提供することにある。

【０００８】

【課題を解決するための手段】上述の問題点を解決するために、本発明の強誘電体電子放出冷陰極は、強誘電体の両主面に裏面電極と上面電極とを有してなる強誘電体電子放出冷陰極において、上面電極の形成された強誘電体の他方主面上に、電子放出能の高い材料、例えばＭｇＯ、ＺｎＯ、CeO_2、Y_2O_3、ＢａＯ、ＣａＯ、ＳｒＯ等からなる保護膜を形成した。

【０００９】このように、電子の放出される主面上に電子放出能の高い材料からなる保護膜を形成することにより、寿命および放出電子量の安定性のいずれの面においても、従来の冷陰極よりも格段に優れた強誘電体電子放出冷陰極を得られることを本発明者らは見い出し、本発明を完成させるにいたった。本発明の構成を採用することにより上述の効果が得られる詳細なメカニズムは現時点では明らかでないが、おそらく分極を急激に反転させることによって強誘電体表面に集中して生じていた作用が、保護膜側に分散、緩和されつつ電子放出能の高い保

護膜からの電子放出が行われることにより、冷陰極の長寿命化、放出量の安定化が図られるものと考えられる。

【００１０】なお本発明に用いる強誘電体としては、ＰＺＴ、ＰＬＺＴ、$BaTiO_3$等のセラミック強誘電体、ＰＶＤＦ等の高分子強誘電体等を用いることができる。強誘電体の厚みは、２０ｎｍ～２０００μｍ、より好ましくは１００ｎｍ～２００μｍが好ましい。これは、使用条件にもよるが、強誘電体の厚みが２０ｎｍより薄くなるとその両面に形成される電極同士が短絡する恐れが高くなり、また、２０００μｍより厚くなると動作電界を非常に大きなものにする必要が生じるからである。また、使用する強誘電体は、バルク状のものを用いても良いし、成膜された薄膜状のものを用いても良い。

【００１１】本発明に用いる電極材料としては、一般的な電極材料をいずれも用いることが可能である。具体的には、Ｐｔ、Ａｕ、Ｃｕ、Ａｌ、Ｎｉ、Ｉｒ、Ｃｓ、Ｃｒ、Ｗ等の金属、およびこれらの合金が挙げられる。なかでも、電子の放出しやすさの面からはＩｒ、Ｃｓ等の仕事関数の低い電極材料が望ましい。電極の形成方法は任意の成膜方法を用いることができるが、蒸着法、スパッタリング法等の成膜技法を用いることが好ましい。これは、後述の通り、本構造の冷陰極においては電極の膜厚が厚くなると電子が放出されにくくなる傾向を有しているからである。

【００１２】本発明の冷陰極で形成される電極（特に上面電極）の膜厚としては、５０００Å以下、より好ましくは５００Å以下が好ましい。電極の膜厚が５０００Åよりも厚くなると、その厚みのため電子の放出が妨げられるためである。この値は使用する電極材料によって若干の変動はあるが、例えば電極材料としてＰｔを用いる場合、１００～５００Å程度が最も好適である。

【００１３】本発明で印加する動作電界は、正あるいは負のいずれでも良く、またいずれの場合もその絶対値において３００ｋＶ／ｃｍ程度以下の範囲が好ましい。３００ｋＶ／ｃｍ程度を越える電界を印加すると、その高電界のため電極および強誘電体が破壊されるという問題が生じるからである。また、動作電界のパルス時間は、正あるいは負どちらとも０．０１～１０００μ秒、より好ましくは５～２００μ秒の範囲が好ましい。０．０１μ秒未満ではパルス時間が短いため充分な電子放出量が得られず、また１０００μ秒を越えて電界を印加しても１０００μ秒以下のパルス時間で放出する電子放出量とほとんど変わらないからである。

【００１４】

【発明の実施の形態】本発明の一実施例の強誘電体電子放出冷陰極１１は主として、図３に示すように、薄板形状の強誘電体１２と、強誘電体１２の裏面全面に形成される下面電極１３と、強誘電体１２の表面にストライプ状に形成される上面電極１４と、上面電極１４を含む表（おもて）面全面に形成される保護膜１５とから構成されている。なお、図３は冷陰極１１の断面形状しか示されていないが、上面電極１４および保護膜１５は奥行き方向にも延びて形成されている。

【００１５】具体的には強誘電体１２としては１０×１５ｍｍ角、５０μｍ厚のバルク状のＰＺＴ薄板が用いられる。また、下面電極１３は膜厚５００ｎｍのＩｒ電極が、上面電極１４は膜厚１００ｎｍのＩｒ電極が、それぞれスパッタリング法によって形成される。ストライプ状の上面電極１４はライン／スペースが５００μｍ／３００μｍに形成される。保護膜１５はＭｇＯ膜からなり、ＥＢ蒸着法によって膜厚１００ｎｍに形成される。

【００１６】ここで、上述の構成の本発明の冷陰極１１と、ＭｇＯ保護膜を形成されない（その他の構成は本発明の冷陰極１１と同一である）従来の冷陰極（図示せず）との二種の試料につき、図４に示す測定装置を用いて、その寿命および放出電子量の安定性を測定する。なお、これら２種の冷陰極を構成する強誘電体には予め電気的に分極処理を施しておく。なお、測定に際しては、上面電極のうちの１本のストライプのみを使用する。

【００１７】以下、測定方法を具体的に説明する。まず図４に示すように、試料２０を真空チャンバ２１内のホルダ２２に固定したうえで試料２０の上面電極を接地する。次いで、パルス印加手段２３によって発生する正負のパルス電圧を下面電極１３に印加する。この時、印加パルスは±２００Ｖ、パルス幅は１０μｓｅｃとする。このパルス電圧の印加によって放出される電子は、試料２０の１０ｍｍ上方に配置されたコレクタ２４に集められる。ここで、この電流が抵抗Ｒを通ることによる電位の変化をオシロスコープ２５を用いて観測して放出電流のピーク値を測定し、このピーク値をもとにオシロスコープの積分演算機能を用いて時間積分することにより放出電子量を算出する。

【００１８】ここで、本発明の冷陰極１１および従来の冷陰極について、上述の測定方法に従って得られた測定結果を対比して図５に示す。図５から読みとれるように、従来の冷陰極では１０回程度のパルス電圧の印加によって電子の放出量がほぼ０となっている。これは、従来技術欄においても説明したように、急激な分極反転の繰り返しにより強誘電体および／または上面電極が劣化したためと考えられる。一方、保護膜１５を形成した本発明の冷陰極１１では、パルス電圧印加回数が１０００回を越えても電圧印加開始当初と同様に電子が放出されており、かつその放出量も充分な安定性を有している。また、保護膜１５を形成することにより放出量自体も従来の冷陰極に比べて３割程度多くなっていることが確認できる。

【００１９】なお、本実施例では保護膜１５の材料としてＭｇＯを用いたが、同様に二次電子放出能の高いＺｎＯ、CeO_2、Y_2O_3、ＢａＯ、ＣａＯ、ＳｒＯの各材料について測定したところ、ＭｇＯ膜を形成した場合と

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同様の効果が得られることが確認できた。また本実施例では、強誘電体１２の表面全面に保護膜１５を形成したが、例えば図６に示すように、強誘電体１２、上面電極１３、エアの３つの境界部付近に保護膜を形成することによっても同種の効果が得られる。加えて、本実施例では強誘電体としてバルク状のＰＺＴ薄板を使用したが、例えばプラズマＣＶＤ法等によって形成した薄膜状のＰＺＴ薄膜を本発明の強誘電体として使用しても構わない。

【００２０】

【発明の効果】このように、電子の放出される主面上に電子放出能の高い材料からなる保護膜を形成することにより、分極を急激に反転させることによって強誘電体内部に集中して生じていた作用が保護膜側に分散、緩和されつつ保護膜からの電子放出が行われるので、寿命および放出電子量の安定性のいずれの面においても、従来の冷陰極よりも格段に優れた強誘電体電子放出冷陰極を得られる。

【図面の簡単な説明】

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【図１】　従来例の強誘電体電子放出冷陰極を示す断面図である。

【図２】　また別の従来例の強誘電体電子放出冷陰極を示す断面図である。

【図３】　本発明の強誘電体電子放出冷陰極を示す断面図である。

【図４】　強誘電体電子放出冷陰極の特性測定装置を示す概略断面図である。

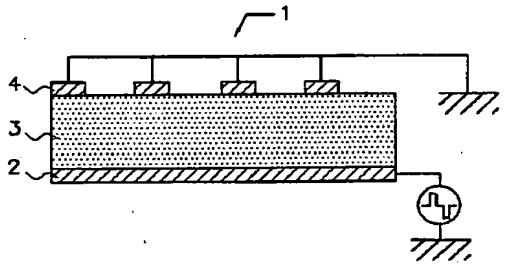
【図５】　本発明の冷陰極と従来の冷陰極の電子放出特性を比較した比較図である。

【図６】　本発明の別の実施例の冷陰極を示す断面図である。

【符号の説明】

１１　・・・　強誘電体電子放出冷陰極
１２　・・・　強誘電体
１３　・・・　下面電極
１４　・・・　上面電極
１５　・・・　保護膜

【図１】



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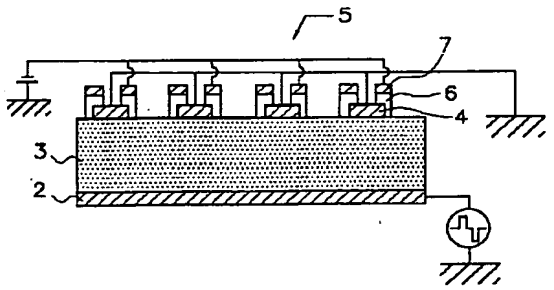

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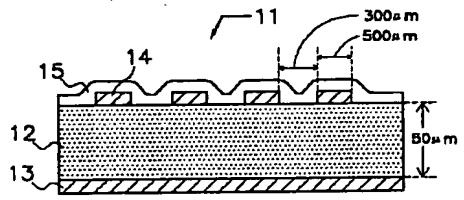

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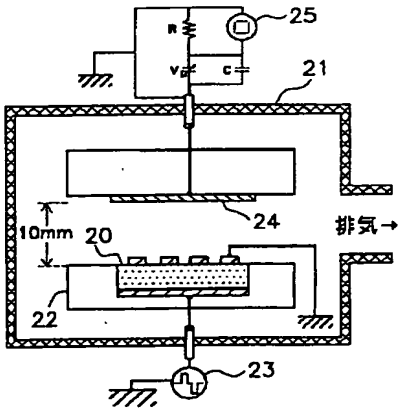

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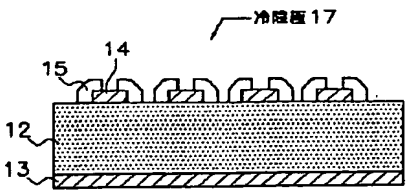

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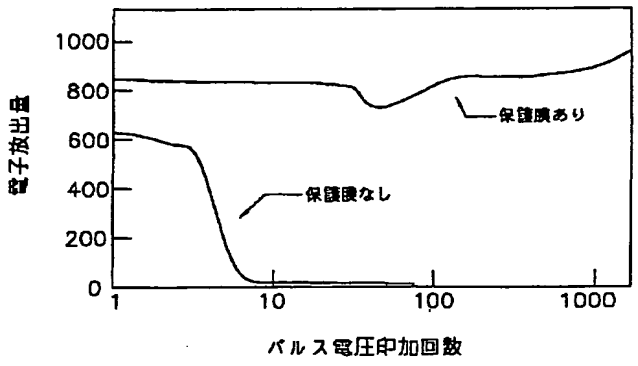
1000
800
600
400
200
0
1
10
100
1000
電子放出量
保護膜あり
保護膜なし
パルス電圧印加回数

* NOTICES *

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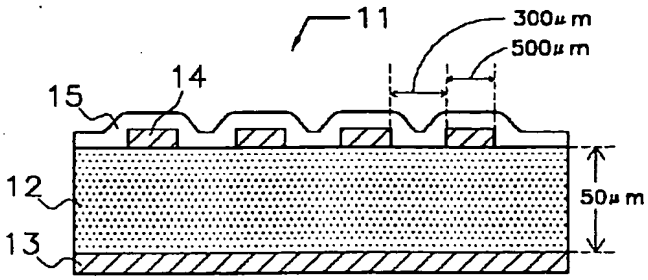
CLAIMS

[Claim(s)]
[Claim 1] Ferroelectric electron emission cold cathode which is the ferroelectric electron emission cold cathode which comes to have the ferroelectric which has spontaneous polarization, the rear-face electrode of a ferroelectric formed in a principal plane on the other hand, and the top-face electrode formed in the another side principal plane of a ferroelectric, and is characterized by forming the protective coat which consists of a high ingredient of electron emission ability on the another side principal plane of the ferroelectric with which said top-face electrode was formed.
[Claim 2] Ferroelectric electron emission cold cathode according to claim 1 characterized by using at least one sort chosen from MgO, ZnO, CeO2, Y2O3, and BaO, CaO and SrO as an ingredient of said protective coat.
[Claim 3] Ferroelectric electron emission cold cathode according to claim 1 to which said top-face electrode is characterized by being formed the shape of a stripe, the shape of a mesh, and in the shape of an array.

[Translation done.]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the structure of the electron emission cold cathode especially using a ferroelectric about the electron emission cold cathode used as an electron source.
[0002]
[Description of the Prior Art] It is possible to change this to a ferroelectric by the spontaneous polarization produced by the permanent dipole located in a line with parallel or anti-parallel existing, and giving a perturbation from the exterior. For example, if the polarization change by electric field is observed as polarization hysteresis (hysteresis) and stress and a temperature change are given, it will become the piezo-electric effect and a pyroelectric effect, respectively, and it will appear. Although these phenomena are observed by receipts and payments of the charge to the electrode formed on the ferroelectric, the emission of the electron from a ferroelectric of them is also attained by choosing the configuration of an electrode or a formation location, thickness, etc. appropriately.
[0003] About the electron emission phenomenon from an above-mentioned ferroelectric, more various researches than before are done, for example, various kinds of experiments referred to as giving perturbations, such as impression of electric field, a temperature change, and an optical exposure, from the exterior to the typical ferroelectric single crystal of BaTiO3 grade, and carrying out induction of the polarization change to it were conducted. However, 10-9 A/cm2 and since the current density of the electron emitted using the polarization change with these comparatively loose experiments was also very small, it was considered that the application to a practical device is difficult. However, since it was reported by H.Gundel and others that recent years come and about two 10 - 102 A/cm electron emission is made by impressing high-speed pulse electric field to ferroelectric ceramics, such as titanic-acid lead zirconate (it abbreviating to PZT hereafter) and PLZT which added little La to this, the opportunity to which it is going to apply this phenomenon to an electron device is growing.
[0004] For example, as shown in drawing 1 , the ferroelectric electron emission cold cathode 1 reported by H.Gundel and others uses the inferior-surface-of-tongue electrode 2, a ferroelectric 3, and the top-face electrode 4 as the main component, and as the ferroelectric electron emission cold cathode 5 indicated by JP,5-325777,A is shown in drawing 2 , in addition to the inferior-surface-of-tongue electrode 2, the ferroelectric 3, and the top-face electrode 4, it is using the insulator layer 6 and the auxiliary electrode 7 as the main component. By impressing an alternating electric field between an inferior-surface-of-tongue electrode and a top-face electrode, the ferroelectric electron emission cold cathode of a configuration of having been shown in these drawing 1 and drawing 2 makes change (polarization reversal) of polarization produce inside a ferroelectric in connection with the abrupt change of the electric field, flies soon the electron which exists near the top-face electrode in that case depending on Coulomb force, and is considered to be what emits an electron.
[0005]
[Problem(s) to be Solved by the Invention] However, above-mentioned ferroelectric electron emission cold cathode had the following troubles.
[0006] That is, if it is in the conventional cold cathode and the actuation which an alternating electric field is impressed [actuation] between an inferior-surface-of-tongue electrode and a top-face electrode, and makes polarization reversal produce in a ferroelectric is repeated, fatigue and degradation will arise inside a ferroelectric front face and/or a top-face electrode, and electronic emission will no longer be performed gradually. Since this degradation usually arose in impression of several - about dozens of times of pulse voltages, it was impossible to have presented practical use with this cold cathode as it is. Although making small the absolute value of the pulse voltage impressed in order to control this degradation is also considered, the problem that the current density of the electron emitted in this case becomes

small newly arises. Moreover, in the conventional cold cathode, the amount only of electron emission which is still satisfactory enough was not obtained, and it had the trouble that the burst size was also referred to as unstable.
[0007] The present condition is that electron emission cold cathode using these troubles to a ferroelectric is not yet put in practical use. Therefore, the purpose of this invention conquers an above-mentioned technical issue point, and its life is long and is to offer the ferroelectric electron emission cold cathode obtained by being stabilized in the burst size of a big electron.
[0008]
[Means for Solving the Problem] In order to solve an above-mentioned trouble, the ferroelectric electron emission cold cathode of this invention formed the protective coat which consists of the high ingredient, MgO, ZnO, and CeO2, of electron emission ability, Y2O3, BaO, CaO, SrO, etc. on the another side principal plane of the ferroelectric with which the top-face electrode was formed in both the principal planes of a ferroelectric in the ferroelectric electron emission cold cathode which comes to have a rear-face electrode and a top-face electrode. [for example,]
[0009] thus, by forming the protective coat which consists of a high ingredient of electron emission ability on the principal plane to which an electron is emitted, also in which field of the stability of a life and the amount of emission electron, this invention persons find out that the ferroelectric electron emission cold cathode which was markedly alike and was superior to the conventional cold cathode can be obtained, and it came to complete this invention. Although the detailed mechanism from which above-mentioned effectiveness is acquired by adopting the configuration of this invention is not clear at present, it is thought by performing electron emission from the high protective coat of electron emission ability that reinforcement of cold cathode and stabilization of a burst size are attained, the operation which concentrated on the ferroelectric front face and had been produced by probably reversing polarization rapidly being distributed and eased at a protective coat side.
[0010] In addition, as a ferroelectric used for this invention, macromolecule ferroelectrics, such as PZT, PLZT, a ceramic ferroelectric of BaTiO3 grade, and PVDF, etc. can be used. The thickness of a ferroelectric has 100nm - more preferably desirable 200 micrometers 20nm - 2000 micrometers. Although this is based also on a service condition, it is because it will be necessary to make electric field of operation very big if a possibility that the electrodes formed in the both sides may short-circuit will become high if the thickness of a ferroelectric becomes thinner than 20nm, and it becomes thicker than 2000 micrometers. Moreover, a bulk-like thing may be used for the ferroelectric to be used and the thing of the shape of a formed thin film may be used for it.
[0011] It is possible to use each common electrode material as an electrode material used for this invention. Specifically, metals, such as Pt, Au, Cu, aluminum, nickel, Ir, Cs, Cr, and W, and these alloys are mentioned. Especially, from the field of the electronic ease of emitting, the low electrode material of work functions, such as Ir and Cs, is desirable. Although the formation approach of an electrode can use the membrane formation approach of arbitration, it is desirable to use membrane formation techniques, such as vacuum deposition and the sputtering method. This is because it has the inclination as for which an electron becomes is hard to be emitted as below-mentioned if the thickness of an electrode becomes thick in the cold cathode of this structure.
[0012] As thickness of the electrode (especially top-face electrode) formed by the cold cathode of this invention, 500A or less is more preferably desirable 5000A or less. When the thickness of an electrode becomes thicker than 5000A, it is because electronic emission is barred for the thickness. Although there is some fluctuation with the electrode material which uses this value, when using Pt, for example as an electrode material, about 100-500A is the most suitable.
[0013] Forward or negative any are sufficient as the electric field of operation impressed by this invention, and, in any case, the range below 300 kV/cm extent is desirable in the absolute value. It is because the problem that an electrode and a ferroelectric are destroyed for [the] high electric field will arise if the electric field exceeding 300 kV/cm extent are impressed. moreover, the pulse period of electric field of operation -- forward or negative -- as for the range for 5 - 200 microseconds, which is more preferably desirable for 0.01 to 1000 microseconds. It is because a pulse period is short, so it hardly changes to the amount of electron emission emitted by the pulse period for 1000 or less microseconds in less than 0.01 microseconds even if sufficient amount of electron emission is not obtained and it impresses electric field exceeding 1000 microseconds.
[0014]
[Embodiment of the Invention] The ferroelectric electron emission cold cathode 11 of one example of this invention consists of the ferroelectric 12 of form of sheet, an inferior-surface-of-tongue electrode 13 formed all over the rear face of a ferroelectric 12, a top-face electrode 14 formed in the front face of a ferroelectric 12 in the shape of a stripe, and a protective coat 15 formed all over the table (bow) side containing the top-face electrode 14, mainly as shown in drawing 3 . In addition, although, as for drawing 3 , only the cross-section configuration of cold cathode 11 is shown, the top-face electrode 14 and the protective coat 15 are extended and formed also in the depth direction.

[0015] Specifically as a ferroelectric 12, the PZT sheet metal of the shape of 10x15mm angle and bulk of 50-micrometer thickness is used. Moreover, as for the inferior-surface-of-tongue electrode 13, Ir electrode of 100nm of thickness is formed for Ir electrode of 500nm of thickness by the sputtering method, respectively, as for the top-face electrode 14. As for the stripe-like top-face electrode 14, Rhine/tooth space is formed in 500 micrometers / 300 micrometers. A protective coat 15 consists of MgO film, and is formed in 100nm of thickness by EB vacuum deposition.
[0016] Here, the stability of the life and the amount of emission electron is measured using the measuring device shown in drawing 4 about two sorts of samples of the cold cathode 11 of this invention of an above-mentioned configuration, and the conventional (other configurations are the same as that of the cold cathode 11 of this invention) cold cathode (not shown) which does not have a MgO protective coat formed. In addition, polarization processing is beforehand performed to the ferroelectric which constitutes these two sorts of cold cathode electrically. In addition, on the occasion of measurement, only one stripe in a top-face electrode is used.
[0017] Hereafter, a measuring method is explained concretely. As first shown in drawing 4 , after fixing a sample 20 to the holder 22 in the vacuum chamber 21, the top-face electrode of a sample 20 is grounded. Subsequently, the pulse voltage of the positive/negative generated with the pulse impression means 23 is impressed to the inferior-surface-of-tongue electrode 13. At this time, an impression pulse is set to **200V and pulse width is set to 10microsec. The electron emitted by impression of this pulse voltage is brought together in the collector 24 arranged in 10mm upper part of a sample 20. Here, change of the potential by this current passing along Resistance R is observed using an oscilloscope 25, the peak value of the emission current is measured, and the amount of emission electron is computed by using and carrying out time quadrature of the integration operator function of an oscilloscope based on this peak value.
[0018] Here, the measurement result obtained about the cold cathode 11 and the conventional cold cathode of this invention according to the above-mentioned measuring method is shown in drawing 5 by comparison. In the conventional cold cathode, the electronic burst size is about 0 by impression of about 10 times of pulse voltages so that it can read in drawing 5 . Since the ferroelectric and/or the top-face electrode deteriorated by the repeat of rapid polarization reversal as explained also in the conventional technical column, this is considered. On the other hand, in the cold cathode 11 of this invention in which the protective coat 15 was formed, even if the count of pulse-voltage impression exceeds 1000 times, the electron is emitted like the time of electrical-potential-difference impression initiation, and the burst size also has sufficient stability. Moreover, it can check that the burst size itself has increased about 30 percent compared with the conventional cold cathode by forming a protective coat 15.
[0019] In addition, although MgO was used as an ingredient of a protective coat 15 in this example, when similarly measured about each ingredient of ZnO with high secondary-electron-emission ability, CeO2, Y2O3, and BaO, CaO and SrO, it has checked that the same effectiveness as the case where the MgO film is formed was acquired. Moreover, in this example, although the protective coat 15 was formed all over the front face of a ferroelectric 12, as shown, for example in drawing 6 , effectiveness of the same kind is acquired also by forming a protective coat a ferroelectric 12, the top-face electrode 13, and near [three] the boundary section of air. In addition, although bulk-like PZT sheet metal was used as a ferroelectric in this example, the PZT thin film of the shape of a thin film formed, for example by the plasma-CVD method etc. may be used as a ferroelectric of this invention.
[0020]
[Effect of the Invention] Thus, by forming the protective coat which consists of a high ingredient of electron emission ability on the principal plane to which an electron is emitted Since electron emission from a protective coat is performed the operation which concentrated on the interior of a ferroelectric and had been produced by reversing polarization rapidly being distributed and eased at a protective coat side also in which field of the stability of a life and the amount of emission electron, the ferroelectric electron emission cold cathode which was markedly alike and was superior to the conventional cold cathode can be obtained.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the ferroelectric electron emission cold cathode of the conventional example.
[Drawing 2] Moreover, it is the sectional view showing the ferroelectric electron emission cold cathode of another conventional example.
[Drawing 3] It is the sectional view showing the ferroelectric electron emission cold cathode of this invention.
[Drawing 4] It is the outline sectional view showing the property measuring device of ferroelectric electron emission cold cathode.
[Drawing 5] It is the comparison Fig. which compared the electron emission characteristic of the cold cathode of this invention, and the conventional cold cathode.
[Drawing 6] It is the sectional view showing the cold cathode of another example of this invention.
[Description of Notations]
11 ... Ferroelectric Electron Emission Cold Cathode
12 ... Ferroelectric
13 ... Inferior-Surface-of-Tongue Electrode
14 ... Top-Face Electrode
15 ... Protective Coat

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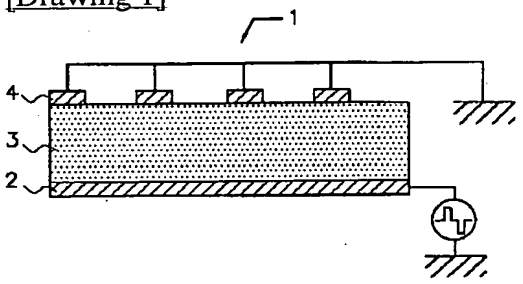
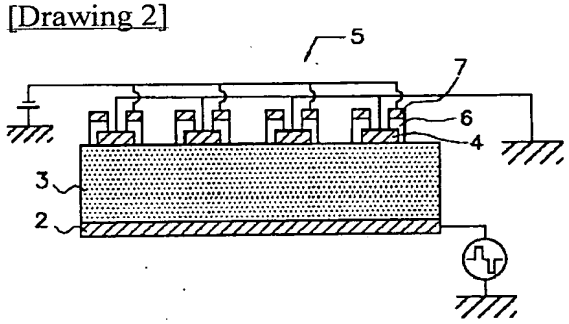
DRAWINGS

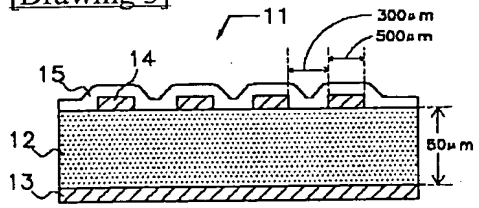
[Drawing 1]



[Drawing 2]



[Drawing 3]



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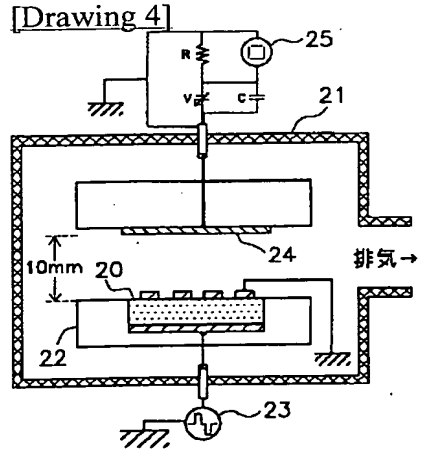
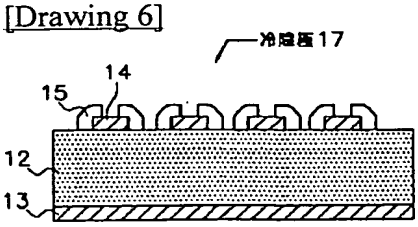
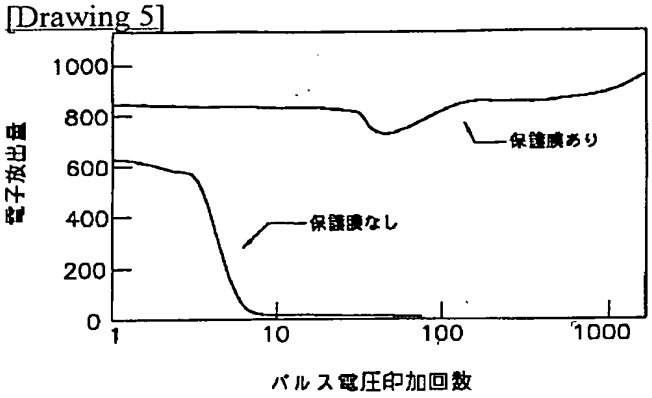


[Drawing 6]



[Drawing 5]



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